2020

CHEMISTRY (Honours)

Paper Code : XI-A & B
(PHYSICAL)
[New Syllabus]

Full Marks : 65   Time : Three Hours

Important Instructions
for Multiple Choice Question (MCQ)

- Write Subject Name and Code, Registration number, Session and Roll number in the space provided on the Answer Script.

  Example : Such as for Paper III-A (MCQ) and III-B (Descriptive).

  Subject Code : III | A | & | B

  Subject Name :

- Candidates are required to attempt all questions (MCQ). Below each question, four alternatives are given [i.e. (A), (B), (C), (D)]. Only one of these alternatives is 'CORRECT' answer. The candidate has to write the Correct Alternative [i.e. (A)/(B)/(C)/(D)] against each Question No. in the Answer Script.

  Example — If alternative A of 1 is correct, then write :
          1. — A

- There is no negative marking for wrong answer.

মাল্টিপল চয়েস প্রশ্নের (MCQ) জন্য জরুরী নির্দেশাবলী

- উত্তরপত্রে নির্দেশিত স্থানে বিষয়ের (Subject) নাম এবং কোড, রেজিস্ট্রেশন নম্বর, সেশন এবং রোল নম্বর লিখতে হবে।

  উদাহরণ — যেমন Paper III-A (MCQ) এবং III-B (Descriptive)।

  Subject Code : | III | A | & | B |

  Subject Name : [   ]

- পরীক্ষার্থীদের সবগুলি প্রশ্নের (MCQ) উত্তর দিতে হবে। প্রতিটি প্রশ্নে চারটি করে সম্ভাব্য উত্তর, যথাক্রমে (A), (B), (C) এবং (D) করে দেওয়া আছে। পরীক্ষার্থীকে তার উত্তরের স্বপক্ষে (A) / (B) / (C) / (D) সঠিক বিকল্পটিকে প্রশ্ন নম্বর উল্লেখসহ উত্তরপত্রে লিখতে হবে।

  উদাহরণ — যদি **1** নম্বর প্রশ্নের সঠিক উত্তর **A** হয় তবে লিখতে হবে :

  1. — A

- ভুল উত্তরের জন্য কোন নেগেটিভ মার্কিং নেই।

Turn Over

Paper Code : XI-A

Full Marks : 15   Time : Thirty Minutes

Choose the correct answer.

Each question carries 1 mark.

1. The value of the commutator $[\hat{x}, \widehat{p_x}]$ is

a) i $\hbar$ b) -i $\hbar$ c) $\hbar$ d) none of the above

2. For which of the following systems is a quantum number of zero not allowed?

a) rigid rotor   b) harmonic oscillator   c) particle in a box   d) anharmonic oscillator

3. If two consecutive energy levels have molecules 1000 and 100 respectively then according to Boltzmann distribution the third level should contain molecules

a) 100   b) 10   c) 1   d) none of the above

4. The coagulation of colloidal particles of the sol can be caused by -

a) heating   b) adding oppositely charged sol

c) adding electrolyte   d) all of the above

5. Lyophilic sols are more stable than lyophobic sols because-

a) the colloidal particles have positive charge.

b) the colloidal particles have negative charge.

c) the colloidal particles are solvated.

d) there are strong electrostatic repulsions between the negatively charged colloidal particles.

6. If the vibrational frequency of HCl is v_1 the vibrational frequency of DCl (deuterium chloride) is -

a) v_1 b) $v_1/2$ c) $2v_1$ d) $0.72v_1$

7. Among the following molecules the shortest bond length is to be found in -

a)Cl_2 b)N_2 c)O_2 d)F_2

8. The conversion of excited singlet state (S_1) of a molecule to a triplet state (T_1) is known as -

a) fluorescence

b) phosphorescence

c) intersystem crossing

d) internal conversion

9. The function $\sin^{-1} x$ (-1, +1) is not an acceptable wave functions because -

a) it is not finite

b) its first derivative is not continuous

c) it does not cover the entire space

d) it is not a single valued function

10. Which of the following will result in deviation from Beer's law -

A. change in refractive index of medium

B. dissociation of an analyte on dilution

C. polychromatic light

D. path length of cuvette

a) A,B and C   b) B,C and D   c) A,C and D   d) A,B and D

11. The interplanar distance ($A^°$) for 100 plane in a cubic structure with lattice parameter $4A^°$

a) 1.   b) 2   c) 4   d) 8

12. Concentration of a reactant decreases linearly with time. What is the order of the reaction?

a) first order   b) fractional-order.   c) second order.   d) zero order

13. Curding from milk is most efficient around -

a) 0°C and pH ≥ 10   b)) 0°C and pH ≤ 4   c) 0°C and 4 ≤ pH ≤10   d) 25°C and 4 ≤ pH ≤ 10

14. The differential rate law equation for the elementary reaction A + 2B $\xrightarrow{\text{k}}$ 3C is-

a) $-d[A]/dt = -d[B]/dt = d[C]/dt = k[A] [B]^2$

b) $-d[A]/dt = - 1/2\, d[B]/dt = 1/3\, d[C]/dt = k[A]^2 [B]$

c) $-d[A]/dt = - 1/2\, d[B]/dt = 1/3\, d[C]/dt = k[A] [B]^2$

d) none of these.

15. Both NaCl and KCl crystallize with the fcc structure. However, x-ray diffraction pattern for

shows fcc structure for NaCl and simple cubic for KCl this is because

a) K^+ and Cl^- are isoelectronic

b) Na^+ and Cl^- are isoelectronic

c) K^+ and Cl^- are disordered in the lattice

d) KCl has anti site defects.

(4)

2020

CHEMISTRY (Honours)

Paper Code : XI-B

(PHYSICAL)

[New Syllabus]

Full Marks : 50   Time : Two Hours Thirty Minutes

The figures in the margin indicate full marks.

Answer any *five* questions taking at least *two* questions from each group.

Group - A

1. a) Find the possible eigen value and eigen-function of the operator d/dx.

b) $\hat{A}= d^2/dx^2$ and $\hat{B}= x$, find out if (e^x +sin x) is an eigen function of ($\hat{A} + \hat{B}$)

c) what is the wavelength associated with a particle of mass 0.1 mgm moving with a speed 1×10^5 cm/s.

d) show that the wave functions –

$\Psi_1 = A \sin \pi x$ and $\Psi_2 = B \sin 2\pi x$
are orthogonal in the interval $0 \le x \le 1$.   [2+3+2+3]

2. a) An object of mass 2.5×10^{-3} kg oscillates with a frequency 0.33 per second calculate the force constant.

b) If and Φ_1 and Φ_2 are two degenerate eigen functions of a linear operator $\hat{A}$,   then a linear combination of the eigen functions is also an eigen function of the operator with same eigen vaue- justify.

c) Show that momentum operator is a hermitian operator.

d) Determine the number of node in 2S wave function.   [3+3+3+1]

3. a) Show that uni-molecular reaction follows a second order kinetics at low reactant concentration.

b) "zero -order reaction must be a multi-step reaction and it goes to completion"- explain.

c) For 10° C rise in temperature the rate constant doubles for a reaction l, triples for reaction ll. If two reactions have comparable pre-exponential factors what is the ratio of their activation energies. [4+3+3]

Turn Over

4. a) Draw the following plots and state the values of slope and intercept in each case

i) log (rate) vs log (reactant concentration) for n^{th} order reaction.

ii) log (initial rate) vs log (substrate concentration) at low substrate concentration for all enzyme catalysed reaction.

iii) log (rate constant) vs pH for a specific acid catalysed process.

b) Discuss the Michaelis- Menten mechanisms of enzyme catalysis.   [(2x3)+4]

Group - B

5. a) Calculate the rotational partition function of a diatomic molecule at high temperature.

b) Two distinguishable particles are distributed among four boxes. How many distributions are possible? Calculate thermodynamic probability of each distribution and comment on most probable distribution. Calculate also the probability of getting any one arrangement.   [4+(2x3)]

6. a) State and explain the third law of thermodynamics.

b) State and explain Schulze - Hardy rule for coagulation of colloids.

c) Deduce the Bragg equation for diffraction of X-ray from crystals.

d) A crystal having simple cubic lattice has the length of its unit cell a_o pm, one of its plane shows a first-order Bragg's reflection at an angle of 60° taking the wavelength of X -rays as a_o pm. Find the Miller indices of the plane.   [2+2+3+3]

7. a) 0.1 M $AlCl_3$ is more effective than 0.1 M NaCl solution in coagulating As_2S_3 sol, while 0.1M $AlCl_3$ is less effective than 0.1 M Na_3PO_4 in coagulating Fe_2O_3 sol. Explain.

b) "Apparently photosynthesizers and catalysts play the same role, but they are different"-explain.

c) State Gibbs adsorption isotherm explaining the terms involved.

d) The quantum yield for the photochemical decomposition

$$2HI \longrightarrow H_2 + I_2$$

at λ equal to 254 nm is 1.99. If 3070 J of energy is absorbed find the number of moles of HI ecomposed.

                    [2+2+3+3]

Turn Over

8. a) How many times does a molecule of $H^1 Cl^{35}$ rotate per second in the J=1 rotational level? Given B= 10.6 cm^{-1}.

b) Will there be any rotational energy at absolute zero?

c) The dipole moment of HCl is 1.03 D and its bond length is 1.27 A. Calculate

    i) the charge on the constituent atoms.

    ii) the percentage ionic character.

 d) A plane of spacing 'd' shows first order Bragg's diffraction at angle θ, where a plane of spacing 2d will show Bragg diffraction ?   [3+1+(2×2)+2]

_____

.